REMARKS

Please reconsider the application in view of the above amendments and the following remarks. Applicant thanks the Examiner for carefully considering this application.

Disposition of Claims

Claims 1, 3-9, 27-30, and 38 are pending in this application. Claims 2, 25, and 26 have been canceled. New claims 39-42 have been added. Claims 1 and 39 are independent. Claim 1 has been amended to include the limitations of claim 2 and specify that the detection of the charged particles impinging on the mark region(s) occurs concurrently with the scanning of the beam of charged particles along a predetermined path over the mask parallel to the direction into which the struts extend. All remaining amendments to claims 1, 4, 7, 8, 9, 27, 28, and 29, as well as addition of new claims, have been made to clarify the invention and have not been made in view of prior art.

New claims 39-42 are fully supported by the original specification and therefore no new matter has been added.

Rejection(s) under 35 U.S.C § 102

Claims 1-3, 9, 25-27 stand rejected under 35 U.S.C. § 102 as anticipated by U.S. Patent No. 6,204,509 ("Yahiro *et al.*"). To the extent that this rejection may still apply to the amended claims, the rejection is respectfully traversed.

The present invention relates to imaging patterns formed on a mask 1 (see Figure 1) onto a radiation sensitive substrate 3. The pattern is defined by scattering regions 9 on a membrane layer 5 of the mask. Electron beams traversing the mask outside of scattering regions 9 are substantially not scattered by the membrane layer 5 and are imaged onto substrate 3 since the un-scattered beams (see beam 11 and 12 of Figure 1) are able to traverse the hole provided in the center of aperture 17. Electron beams traversing the mask through one of the scattering regions 9 defining the pattern are scattered by a substantial angle such that these beams are not able to traverse aperture 7 through its central hole (see beam 13 of Figure 1). This is the basic principle of pattern imaging. The membrane carrying the pattern 9 is supported by solid struts 7. The struts are too thick to be traversed by electrons without scattering. Thus, portions of the membrane 5 overlapping with the struts may not be used for defining the pattern to be imaged, i.e. for providing scattering regions 9 defining the pattern.

Figure 2 shows the arrangement of the supporting struts of the mask, and Figure 3 illustrates how an electron beam cross-section 43 is scanned over the membrane surface between two adjacent struts along a predetermined path 49 (see Figure 3).

More particularly, the invention relates to avoiding deviations from this predetermined path <u>while scanning the beam cross-section over the elongated sub-fields of the membrane defined between adjacent struts</u>.

Referring to Figure 4, mark regions 61 are provided for "guiding" the electron beam cross-section <u>during the scanning operation</u>. An electron beam deviating from the predetermined path is indicated by reference numeral 41' in Figure 4. Electrons incident on the mark region 61 generate a radiation signal 63 which is detected by sensor

65. Thus, the signal of sensor 65 is indicative of a deviation of the electron beam cross-section from its predetermined path.

Claim 1 as amended defines a deflector for moving the beam cross section of a beam of charged particles along the path extending over the mask parallel to the direction of the struts. A sensor detects, <u>concurrently with the scanning operation</u>, a number of charged particles impinging on the mark region(s) provided on the mask. Further, the deflector is responsive to a measuring signal dependent on the number of charged particles detected by the sensor in order to reduce deviations from the path extending over the mask parallel to the direction of the struts.

Yahiro *et al.* disclose detecting distortions in the mask due to, for example, changes in temperature (see column 1, last paragraph). Distortions of the mask result in distortions of the pattern defined by the mask from an initial ("ideal") pattern and, accordingly, distortions of the image of the mask on the radiation sensitive substrate as compared to the desired image are formed (see Figures 3 and 4).

The apparatus according to the Yahiro *et al.* detects the distortion of the mask and compensates resulting deviations of the image by changing properties of the imaging electron beam optics.

In particular, as shown in Figure 2 of Yahiro *et al.*, a mark detection system 25 uses light beams and a camera to detect a mark pattern provided on the mask (see column 9, lines 31 to 47). Deviations of the detected mark pattern from an initial pattern are calculated to determine the deformation of the mask. An operational parameter of the electron beam system is then adjusted to correct the exposed pattern for distortions of the mask (column 10, lines 23 to 52). Also, deflector 4 upstream of the

mask is operated in dependence of the detected distortion by driver 17 (Figure 2, column 10, lines 37 to 45).

The system disclosed in Yahiro *et al.* is able to detect several types of distortions, as illustrated in Figures 4a, 4b, 4c and 4d. For detecting the orthogonality error as illustrated in Figure 4c, it is necessary to determine the current positions of at least four different alignment marks 53 and to compare the calculated positions with their predefined positions 53'. This is possible with the apparatus shown in Figure 2 where a camera is used to detect the pattern of the plurality of alignment marks. The camera system is separated from and independent of the electron beam system used for imaging the pattern. Thus, the detection of the distortion of the mask may be performed concurrently with exposing the substrate with the imaged pattern.

Figures 10 and 11 of Yahiro *et al.* disclose an embodiment where an electron beam is used for detecting positions of the alignment marks. A reflected electron detector 25c is disposed upstream of the electron beam EB with respect to the mask and detects electrons of the electron beam which are incident on one of the alignment marks 57d. To detect the position of the alignment mark, <u>the electron beam EB is scanned over the alignment mark</u> 57d in two dimensions (x and y directions). (See column 15, lines 10 to 13). However, just scanning one single alignment mark is not sufficient for determining the distortion of the mask. For this purpose, position of plural alignment marks have to be determined by independently scanning the plural alignment marks. It is not possible to scan the alignment marks with a beam having a cross-section covering plural alignment marks since the detector 25c will not be able to distinguish reflected electrons originating from one or the other alignment marks such that the

positions of the individual alignment marks may not be determined with such beam having the high beam cross-section.

It follows that, for the purpose of determining the distortion of the mask, it is necessary to scan the electron beam over the plural alignment marks prior to exposing the pattern onto the substrate. Thereafter, the distortion of the mask is then used for adjusting the electron-optical parameter in the subsequent exposure of the pattern in which the electron beam illuminates the mask sub-fields 50 carrying the pattern rather than the alignment marks.

Using the electron beam, it is not possible to determine the distortion of the mask concurrently with the exposure of the mask sub-fields. A memory device 16a (see Figure 10 and description on column 10, lines 35) is provided for storing correction data determined based on the mask distortion detected by scanning the alignment marks with an electron beam having the low beam cross-section. The correction data stored in the memory is then used for controlling the electron beam optics such that the distortion of the mask is compensated to generate an image of the distorted mask which corresponds to the predetermined image of the non-distorted mask.

The apparatus and method as claimed do not compare two mask patterns, for example, a distorted one and an initial pattern in a coordinate system which is independent of the mask. Therefore, the apparatus and method as claimed do not provide a signal for scanning the beam which is product of comparing two mask patterns. Instead, the beam of charged particles is moved based on the signal dependent on the number of charged particles detected by the sensor during the scanning of the beam of charged particle along a predetermined path over the mask parallel to the direction into

which the struts extend.

In view of the above, Yahiro *et al.* fails to show or suggest the invention as recited in the claims. Thus, the claims are patentable over the cited prior art. Accordingly, withdrawal of this rejection is respectfully requested.

Applicant believes this reply is fully responsive to all outstanding issues and places this application in condition for allowance. If this belief is incorrect, or other issues arise, the Examiner is encouraged to contact the undersigned or his associates at the telephone number listed below. Please apply any charges not covered, or any credits, to Deposit Account 50-0591 (Reference Number 03850/010001).

Respectfully submitted,

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